WHAT IS CLAIMED

1. A method for repair and restoration of damaged, injured, diseased or aged cartilage to a functional cartilage, said method comprising steps:

a) preparing a neo-cartilage construct comprising autologous or heterologous chondrocytes incorporated into a sponge, porous scaffold or hydrogel matrix support and subjected to algorithm conditions; and

b) implanting said construct into a cartilage lesion.

2. The method of claim 1 additionally comprising a step of depositing a layer of a biologically acceptable top sealant over said construct implanted into said lesion.

3. The method of claim 2 further comprising a step of depositing a layer of a biologically acceptable bottom sealant over a bottom of said lesion.

4. The method of claim 3 wherein said top and said bottom sealants are the same or different.

5. The method of claim 4 wherein a combination of said construct and said top sealant results in formation and growth of a superficial cartilage layer sealing the cartilage lesion *in situ*.

6. The method of claim 5 wherein said neo-cartilage construct implanted into said cavity is subjected to an algorithm of the invention before its implantation;

wherein said algorithm comprises hydrostatic or atmospheric pressure or non-pressure conditions, rate of perfusion, medium composition, concentration of oxygen, nitrogen or carbon

dioxide, temperature, cell density and time to which the chondrocytes are subjected.

7. The method of claim 6 wherein the support matrix of the neo-cartilage construct is prepared from a material selected from the group consisting of a Type I collagen, a Type II collagen, a Type IV collagen, a cell-contracted collagen containing proteoglycan, a cell-contracted collagen containing glycosaminoglycan, a cell-contracted collagen containing glycoprotein, gelatin, agarose, hyaluronin, fibronectin, laminin, a bioactive peptide growth factor, a cytokine, elastin, fibrin, a synthetic polymeric fiber made of a polylactic acid, a synthetic polymeric fiber made of a polyglycolic acid, polycaprolactone, a polyamino acid, a polypeptide gel, a polymeric thermo-reversible gelling hydrogel (TRGH), a copolymer thereof and a combination thereof.

8. The method of claim 7 wherein the hydrostatic pressure is from about zero MPa to about 10 MPa above atmospheric pressure at about 0.01 to about 1 Hz, wherein the time for applying the hydrostatic pressure is from zero to about 24 hours per day for from about one day to about ninety days, wherein said hydrostatic pressure is preceded or followed by a period of zero to about 24 hours per day of a static atmospheric pressure for from about one day to about ninety days, wherein the flow rate is from about 1 μL/min to about 500 μL/min, wherein the cell density is from about 3 to 60 millions per mL and wherein the oxygen concentration is from about 1% to about 20%.

9. The method of claim 8 wherein the neo-cartilage construct comprises a suspension of chondrocytes in TRGH at a density of from about 12 to about 15 millions per mL, wherein

the hydrostatic cyclic pressure is from about 0.05 MPa to about 3 MPa at 0.1 to about 0.5 Hz or constant pressure is from about zero to about 3 MPa above atmospheric pressure and wherein such pressure is applied for about 7 to about 28 days, wherein said hydrostatic pressure is preceded or followed by a period of about zero to about 28 days of atmospheric pressure and wherein said perfusion flow rate is about 5 µL to about 50 µL and wherein said perfusion is performed in the presence of about 2%to about 5% oxygen.

10. A method for treatment and regeneration of injured, damaged, diseased or aged articular cartilage comprises steps:

a) debriding an articular cartilage lesion;

b) harvesting about 50-4000 mg of hyaline cartilage during debriding;

c) isolating chondrocytes;

d) expanding said chondrocytes in culture;

e) suspending the chondrocytes in a support matrix at a density between about 3 to about 60 million cells per ml thereby generating a neo-cartilage construct;

f) subjecting said construct to an algorithm comprising a cyclic or constant hydrostatic pressure for a period of time from about 7 to about 28 days preceded or followed by a period from about zero to about 28 days of static atmospheric pressure at a perfusion flow rate of about 1 to about 500 µL in the presence of about 1%to about 20% oxygen;

g) implanting said construct of step f) in the lesion of step a); and

h) covering said construct implanted into said lesion with a biologically acceptable top sealant covering the outer surface of the lesion.

11. The method of claim 10 additionally comprising a step of depositing a bottom biologically acceptable sealant at a bottom of the lesion.

12. The method fo claim 11 wherein said top or bottom sealant is selected from the group consisting of gelatin, a copolymer of polyethylene glycol and poly-lactide or poly-glycolide, periodate-oxidized gelatin, 4-armed pentaerythritol thiol and a polyethylene glycol diacrylate, 4-armed tetra-succinimidyl ester or tetra-thiol derivatized PEG, photo-polymerizable polyethylene glycol-co-poly(α-hydroxy acid) diacrylate macromer, 4-armed polyethylene glycols derivatized with succinimidyl ester and thiol plus methylated collagen, hydrogel, derivatized polyethylene glycol (PEG), derivatized polyethylene glycol (PEG) cross-linked with alkylated collagen, tetra-hydrosuccinimidyl or tetra-thiol derivatized PEG, cross-linked PEG with methylated collagen and a combination thereof wherein the first and second sealant are the same or different.

13. The method of claim 12 wherein the sealant is cross-linked PEG with methylated collagen.

14. The method of claim 11 wherein the harvested chondrocytes are non-osteoarthritic or osteoarthritic chondrocytes obtained from a patient during arthroscopy;

wherein the chondrocytes are isolated by a protease, a lyase, both in sequence or in a mixture thereof; and

wherein the chondrocytes are expanded by incubation in culture, suspended in a sol-gel solution or thermo-reversible gelation hydrogel and seeded into a support matrix.

15. The method of claim 14 wherein said support matrix is a sponge, porous scaffold or a hydrogel prepared from a material

selected from the group consisting of a Type I collagen, a Type II collagen, a Type IV collagen, a cell-contracted collagen containing a proteoglycan, a cell-contracted collagen containing a glycosaminoglycan, a cell-contracted collagen containing a glycoprotein, gelatin, agarose, hyaluronin, fibronectin, laminin, a bioactive peptide growth factor, a cytokine, elastin, fibrin, a synthetic polymeric fiber made of a polylactic acid, a synthetic polymeric fiber made of polyglycolic, a synthetic polymeric fiber made of polyamino acid, polycaprolactone, a polyamino acid, a polypeptide gel, a polymeric thermo-reversible gelation hydrogel (TRGH), a copolymer thereof and a combination thereof.

16. The method of claim 15 wherein said matrix is the sponge into which sol-gel suspension is introduced before the hydrostatic pressure is applied or wherein said matrix is TRGH into which the chondrocytes are suspended at a temperature below about 30°C where the TRGH is in a liquid sol form, and which is subsequently converted into a solid gel form by increasing the temperature above about 30° to about 37°C and wherein said solid gel is subjected to the algorithm of step f) to form the neo-cartilage construct.

17. The method of claim 16 wherein said construct is implanted into said lesion into a cavity formed between said top sealant layer and said bottom sealant layer.

18. The method of claim 17 wherein said construct is said TRGH incorporated with chondrocytes, wherein said construct is cooled to temperatures below 30°C to be converted into the liquid sol and implanted as the sol and wherein upon warming said sol to the body temperature said sol is converted into the solid gel filling said lesion cavity.

19. The method of claim 18 wherein the neo-cartilage construct comprises a suspension of chondrocytes in TRGH, wherein said cyclic hydrostatic pressure is about 3.0 MPa at 0.1 Hz or constant hydrostatic pressure is from zero to about 3 MPa applied for about 7 days preceded or followed by the static atmospheric pressure applied for about 12 days wherein said perfusion flow rate is about 5 µL and wherein said perfusion is performed in the presence of about 2%to about 5% oxygen.

20. The method of claim 16 wherein said construct is a sponge incorporated with chondrocytes and said construct is implanted above the bottom sealant into said lesion after the deposition of the bottom sealant and before the deposition of the top sealant.